

A MULTI-INSTRUMENT SPECTRAL VIEW OF EUROPA FROM GALILEO.

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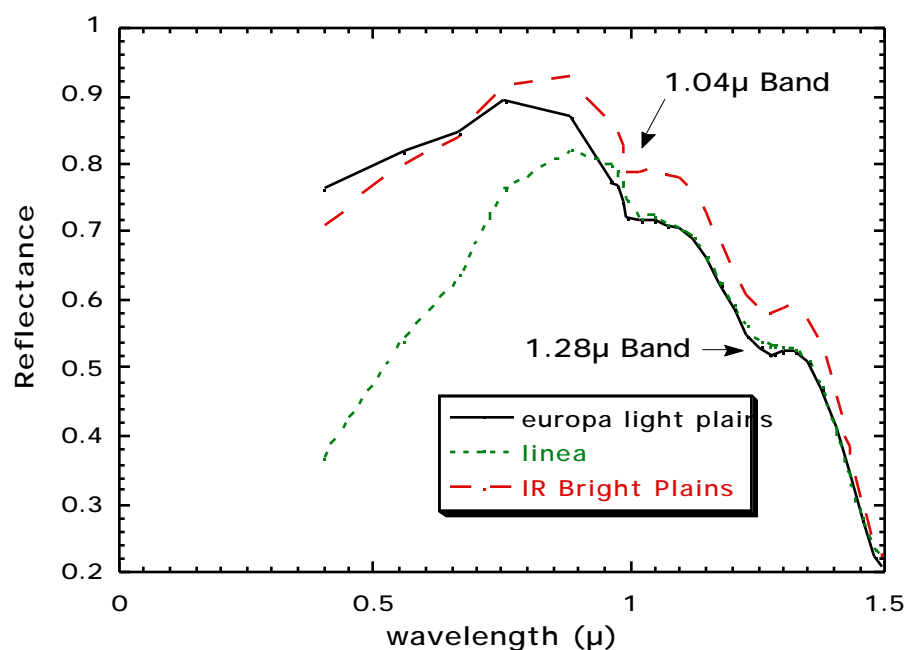
The Galileo spacecraft has observed the Jovian satellite, Europa, using a variety of instruments which include the Solid State Imager (SSI, a CCD camera) and the Near Infrared Mapping Spectrometer (NIMS). In particular, these instruments collected a sequence of overlapping multi-wavelength observations of Europa during the first Ganymede encounter orbit (otherwise known as G1). The SSI instrument recorded a set of six multispectral images (with effective bandcenters at 0.404, 0.560, 0.671, 0.756, 0.889, and 0.968 μ) of Europa's north pole region at a resolution of 1.6 km/pixel. Similarly, NIMS obtained a 228 channel image (ranging between 0.73 to 5.2 μ) dataset of the north pole region of Europa at a resolution of 39.4 km/pixels. This study combines these two data sets to take advantage of the combined visible and infrared wavelength range to study the composition of the optical surface and to map such compositions into the visual wavelength features.

Previous studies of the above data sets raised interesting questions which a combined instrument study might resolve. Initial studies of the Europa NIMS data [3] confirmed the strong water ice spectral signature seen from observatories on Earth [2] and showed that some of the spectra matched well with water ice with a 200 μ grain size range. The SSI color data found a variety of interesting features including a spectral turn down in the 0.889 and 0.968 μ filters and previously unknown "infrared bright" plains or patches which were observed in the images taken through the same filters ([1] and [5]). Several questions arise from comparing these two observations. It has been suggested that the near infrared turn down seen in the SSI dataset is primarily due to the shape of the 1.04 μ water ice band. Is this indeed the case? The "infrared bright" plains or patches can only be seen in the near infrared images. What is their infrared spectrum like and what does this imply about the geology of these "infrared

bright" patches? Similarly, can infrared data tell us more about the dark materials which make up the linea and triple bands on Europa?

Figure 1 (Visible/NIR Europa Spectra) illustrates some of the visible and near infrared spectra from this data merge. Each spectrum displayed in this plot is of one sample from the merged data set with a typical signature of that geologic feature type. In all of the spectra seen in this plot it appears that the water ice spectral signature of the 1.04 μ band does appear to be a dominating factor which would effect the spectra signatures as seen in the 0.889 and 0.968 μ filters. The infrared bright plains spectrum appears to have a deeper 1.04 μ and 1.28 μ bands than the other spectra depicted implying either a larger water ice grain size or a purer water ice [4] than other queried spectral types sampled for this plot. The infrared portion of these spectra also help us understand why the infrared bright plains stand out in the 0.889 and 0.968 images. In the near infrared some of the linear and the surrounding light plains have nearly the same spectral response while having a different spectral signature in visible wavelengths. It appears that the spectral signature of water ice is so strong in the infrared (between 1-3 μ) that there is very little, if any, spectral features of the dark component present in the infrared portion of this data set. It has also been shown that this "dark" component found in the linea appear to fade through time to have similar SSI wavelength spectra to that of the "light plains" ([1] and [5]). This suggests that some process allows the water ice spectral signature to obscure or degrade the "dark" spectral component as time progresses. The visible spectra also tell us why these "infrared bright" features were not spotted by the Voyager spacecraft. The visible spectral response of the "infrared bright" plains or patches has a similar spectral response to that of the surrounding "light plains".

Figure 1.
VISIBLE/NIR EUROPA SPECTRA



References: [1] Belton, M.J.S. *et al.* (1996) Galileo's first images of Jupiter and the Galilean Satellites, *Science*, Vol. 274, pp. 377-385. [2] Calvin, W.M. *et al.* (1995) Spectra of the icy Galilean satellites from 0.2 to 5 μ m: A compilation, new observations, and a recent summary, *JGR*, Vol. 100, pp. 19041-19048. [3] Carlson, R.W. *et al.* (1996) Near-infrared spectroscopy and spectral mapping of Jupiter and the Galilean Satellites: Results from Galileo's initial orbit, *Science*, Vol. 274, pp. 385-388. [4] Clark, R.N. (1980) Ganymede, Europa, Callisto, and Saturn's Rings: Compositional analysis from reflectance spectroscopy. [5] Geissler, P. *et al.* (1996) Multispectral imaging of Europa from Galileo's G1 encounter, *EOS, Transactions, AGU* Vol. 77, No. 46, pp. F438.